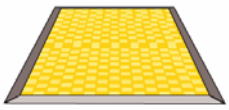
Safety Mat Control Using CompactBlock Guard I/O and GuardLogix Integrated Safety Controller

Safety Network-enabled Example
Safety Rating: Category 3, according to EN954-1



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Introduction

This example shows how to wire, configure and program a GuardLogix integrated safety controller with a CompactBlock Guard I/O module for use with a dual channel safety mat and a dual channel e-stop.

Features and Benefits

- Uses programmable safety logic to control and monitor the status of a safety mat.
- Expandable as needed by adding additional safety inputs or outputs.
- Easier integration into Logix controllers and HMIs through standard DeviceNet control systems.
- Seamless communication of both safety and standard data using CIP Safety on DeviceNet networks.

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING	Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
SHOCK HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
BURN HAZARD	Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

General Safety Information

IMPORTANT	This application example is for advanced users and assumes that you are trained and experienced in safety system requirements.
ATTENTION	A risk assessment should be performed to make sure all task and hazard combinations have been identified and addressed. The risk assessment may require additional circuitry to reduce the risk to a tolerable level. Safety circuits must take into consideration safety distance calculations which are not part of the scope of this document.

Contact Rockwell Automation to find out more about our safety risk assessment services.

Description

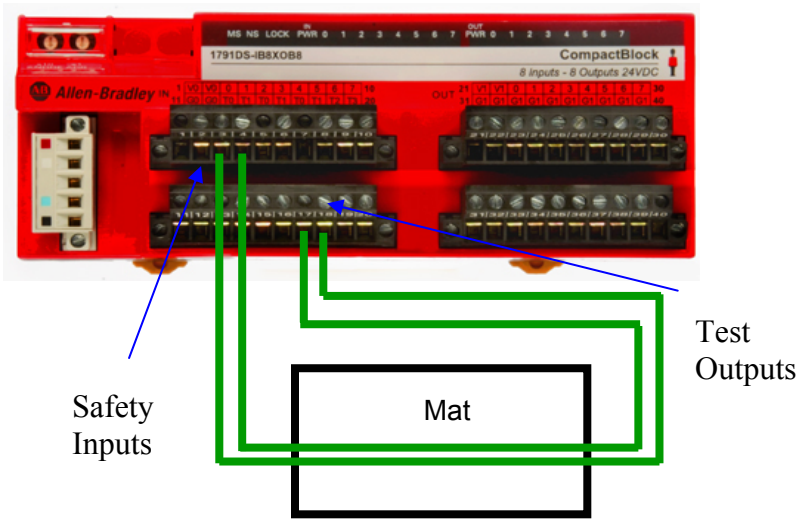
This document details how to interface a safety mat directly into a 1791DS Guard I/O module and maintain, at a minimum, a CAT3 safety rating. This document will describe the operational theory, fault detection, GuardLogix code and field wiring requirements.

The GuardLogix controller is programmed using RSLogix 5000 software. You must be familiar with this software to use this document.

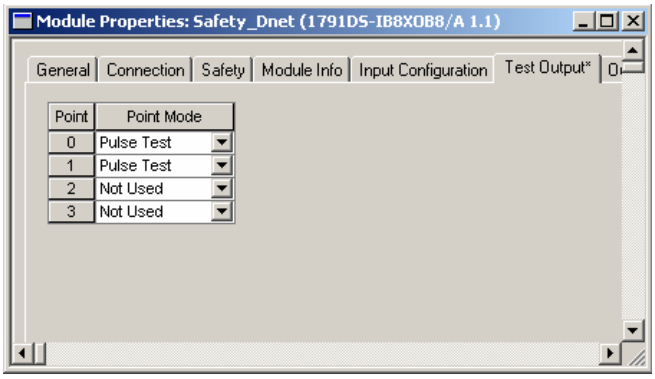
Safety Function

ATTENTION	This application example assumes use of a dual-channel safety mat. It also assumes that the dual channels are shorted together whenever the safety mat is stepped on. Unfortunately, when this type of safety mat is wired directly into a 1791DS I/O module, there is simply no way to distinguish between an actual wiring short between the two channels, and stepping onto the mat. When either situation occurs, a short is created between the channels. For this reason, Machine STOP must be the go-to state when the mat is stepped on. In other words, the machine can never START due to a channel-to-channel field wiring short, and this would be possible if stepping onto the mat caused the machine to start. The GuardLogix controller must be capable of detecting the channel-to-channel short that is caused by stepping onto the mat. The easiest method to detect this channel-to-channel short is to perform a pulse test. This diagram shows the wiring for a typical pulse-tested circuit. The GuardLogix controller uses the 1791DS DeviceNet Safety CompactBlock Guard I/O Module. 1791DS test outputs supply 24V dc for the circuits. They can be configured, as described on the following page, to automatically generate a pulse test.

Safety Mat Connections to I/O Module



Module Test Outputs



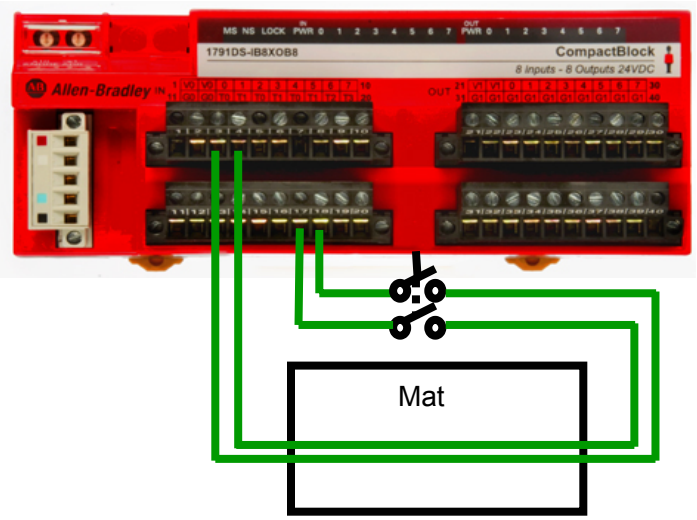
Pulse-testing Basics

Both channel sources (of 24V dc) of any safety input are normally HI, and thus the channel inputs are HI as well. But if one source is pulsed LO, then the corresponding channel input should go LO as well. If the input follows the output LO, then the pulse test passes. But if the pulsed LO channel has another path to 24V dc, such as a channel-to-channel short, the input channel will not go LO, and the pulse test will fail. This is how the GuardLogix controller detects when the mat has been stepped on.

1791DS DeviceNet Safety I/O Modules are capable of performing on-board pulse-testing without any additional code in the GuardLogix controller. However, when the 1791DS modules detect a pulse test failure, the inputs of the failed channels fault, and remain faulted until the input channels go LO (0V dc). Since stepping on the mat does not set the channels LO, the only way to generate a LO signal is to break the channels by using an inline switch.

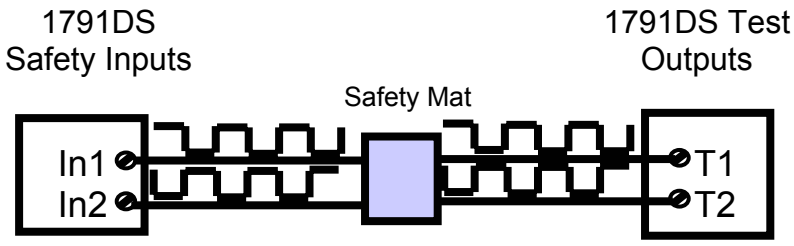
The following diagram shows an inline switch that can be opened to generate the LO signals required to reset the 1791DS inputs in response to an on-board pulse test fault.

Safety Mat with Switch



This application example assumes that this additional inline switch will not be acceptable, and presents an alternate solution. This other solution will not use the on-board configurable pulse-testing for the reasons described above.

This application example shows how to generate the pulse test by toggling two (2) 1971DS Test outputs HI and LO using ladder logic.



Using simple ladder logic, these outputs are toggled HI and LO, causing the inputs to toggle HI and LO as well. If the mat has not been stepped on, the inputs should always be diverse; one input HI and one input LO. But when the mat is stepped on, a channel-to-channel short occurs, and the HI channel has a path to both inputs. The software detects that the inputs are no longer diverse and drops out the safety mat output.

The advantage of using ladder logic, rather than on-board pulse-testing, is that any 1791DS faults (shorts to 24V dc, shorts to V dc, channel-to-channel short) are temporary and are automatically reset when the fault is cleared; for example stepping off the mat.

All three 1791DS modules have test outputs capable of supporting this application. All three 1791DS modules have four test outputs, and so two remain for other uses.

The following faults are detected:

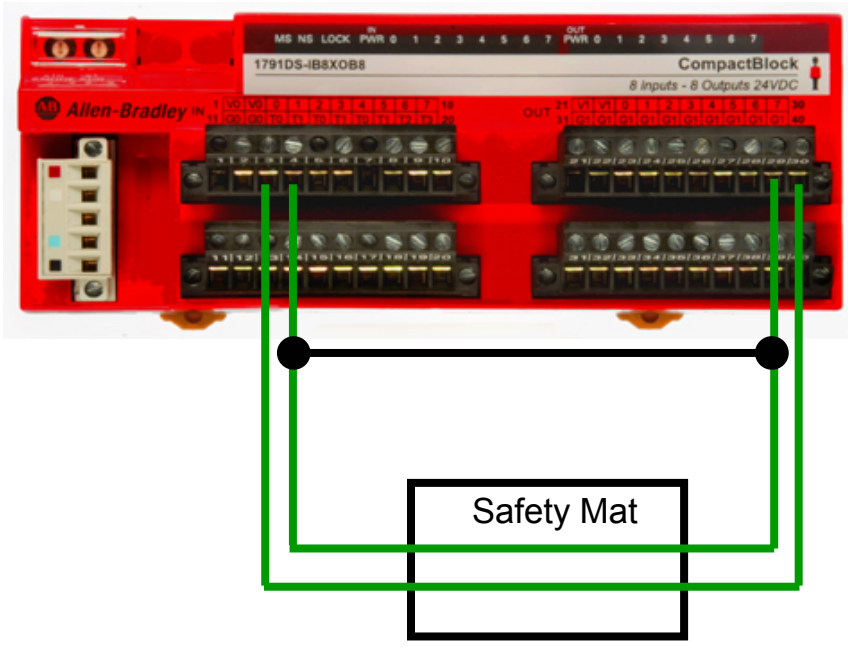
- Mat stepped on / channel-to-channel short (cannot differentiate between these).
- chA shorted to 24V dc
- chB shorted to 24V dc
- chA shorted to GND
- chA wire break
- chB shorted to GND
- chB wire break
- DeviceNet Fault (not in this code; easy to monitor)

Fault Exclusion Affecting Category Rating

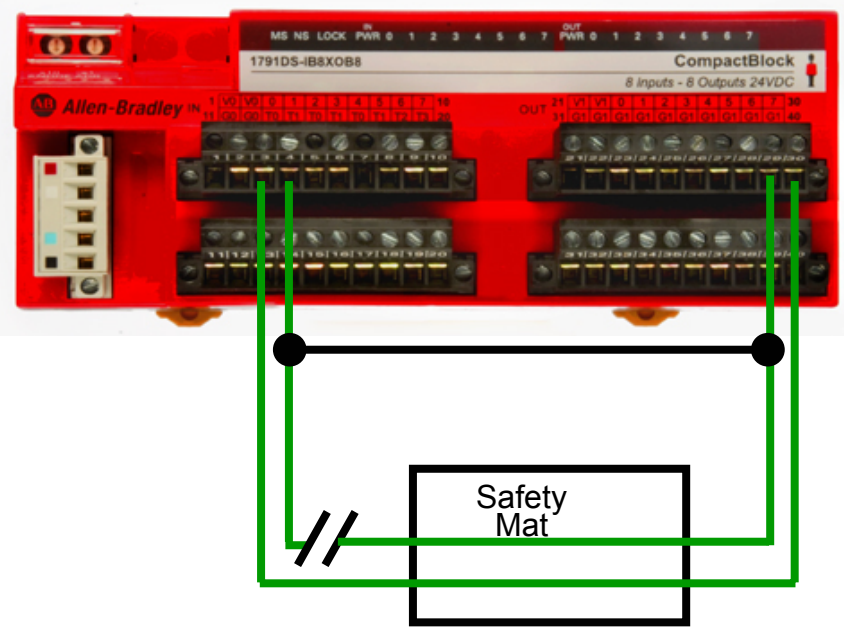
There is one combination of faults that could cause a dangerous failure of the safety mat in this application. The three faults must occur in a particular order to create this dangerous situation. The three faults are:

- channel short around the safety mat.
- wire OFF between either side of the safety mat and short.
- wire OFF between the other side of the safety mat and short.

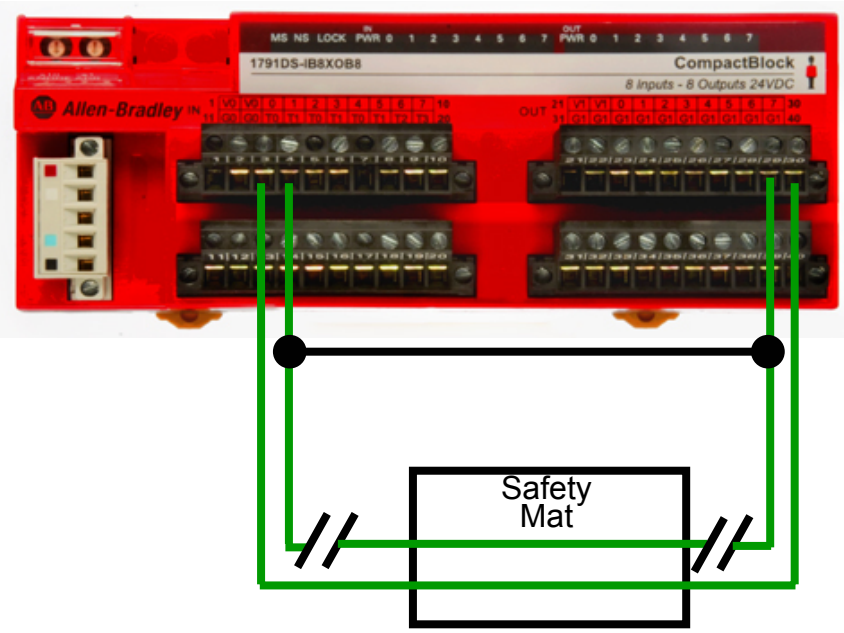
First, a channel short around the safety mat. This does not change the circuit at all, and is undetectable because the circuit is not broken when the mat is stepped on.



Second, wire OFF on either side of the safety mat. Because of the initial short, the wire OFF is undetectable. When the mat is stepped on, the channels still short together, and there remains a path between the mat and input.



Third, wire OFF on the other side of the safety mat. After this third fault, there is a dangerous failure of the safety mat. If the mat is stepped on, there is no channel-to-channel short between the two channels, and thus the safety mat output will remain energized.



If no action is taken to detect these faults as they occur, then this safety mat application will have to be rated to CAT3. One possible method to detect this condition is to place a switch on either side of the mat. After the first fault, opening this switch will not drop out the input, thus detecting the short around the mat.

This example meets the requirements of Category 3 according to EN954-1.

Example Bill of Material

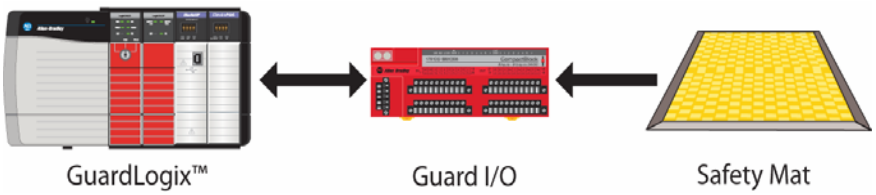
This functional safety example uses these components.

Catalog Number	Description	Quantity
1756-L62S	GuardLogix CPU	1
1756-LSP	GuardLogix safety partner	1
1791DS-IB8XOB8	CompactBlock Guard I/O module on DeviceNet (8 safety inputs, 4 pulse test / standard outputs, 8 safety outputs)	1
1606-SL	24V DC power supply	1
1756-A10/B	ControlLogix chassis	
1756-PA72	ControlLogix power supply	1
1756-ENBT	ControlLogix ENBT module	1
1756-DNB	ControlLogix DNB module	1
440F-M2010BYNN	39.4” x 19.7” MatGuard safety mat	1

Setup and Wiring

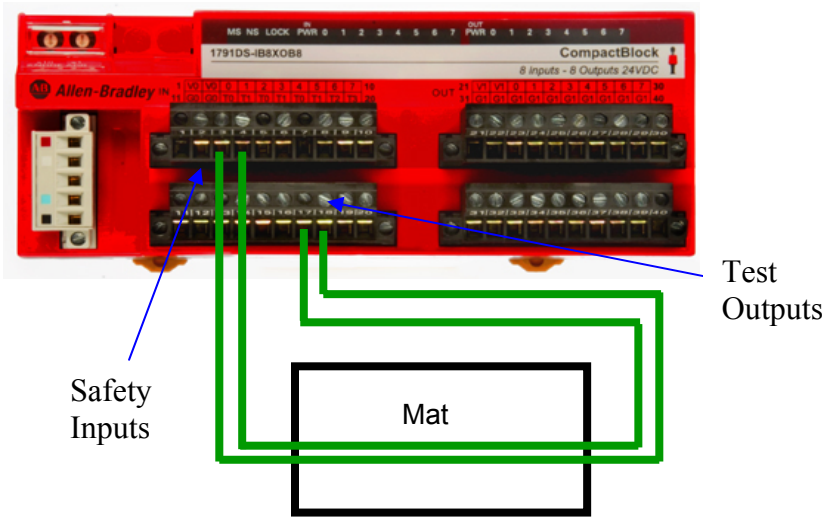
For detailed information on installing and wiring, refer to the product manuals listed in the Additional Resources on page 26.

System Overview



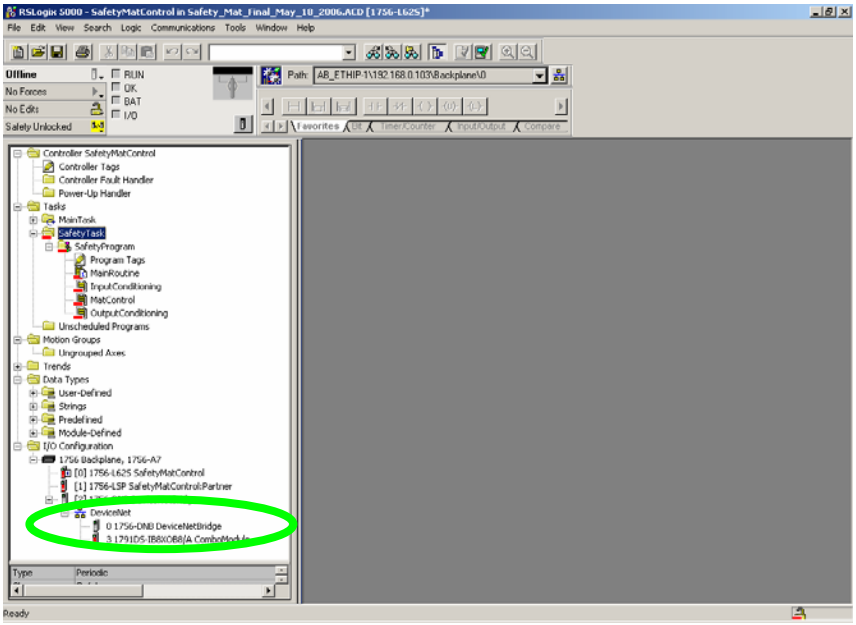
Wiring

The following diagram shows how the safety mat is wired using two test outputs.

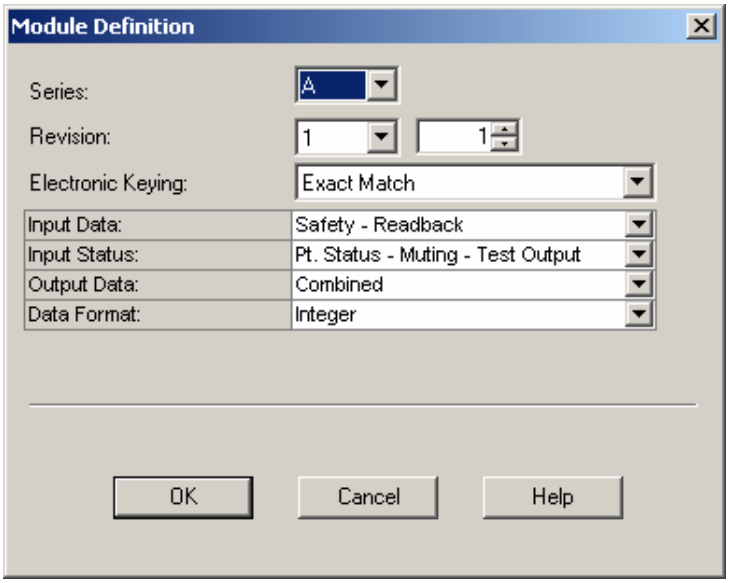


Configure

To support the hardware configuration shown above, the following configuration was used. The 1791DS-IB8XOB8 module was added to the I/O configuration under the 1756-DNB DeviceNet Bridge module, as shown.



The 1791DS-IB8XOB8 module is configured as follows.



The options for Input Data are:

- Point Status / Muting.
- Combined Status / Muting.
- Point Status / Muting / Test Output.

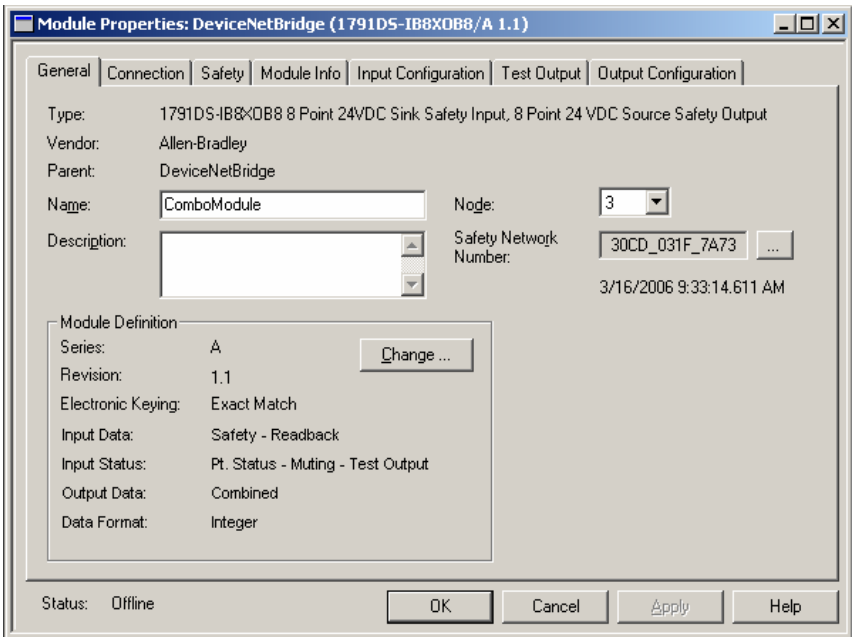
Combined status lumps all eight input point status into a single bit, and the same for the outputs. Point Status provides an individual status bit for each I/O point. To obtain the Test Output status, select the option with Test Output.

The options for Output Data are:

- Safety.
- Test.
- Combined.

Safety provides tags to control the 8 safety outputs. Test provides tags to control the 4 test outputs. Combined provides 12 tags for 8 safety outputs and 4 test outputs. Since we are using the test outputs, select Combined.

The only choice for Data Format is Integer.



The only other options under the General tab are DeviceNet Node number and Safety Network Number. The DeviceNet Node number is set using the rotary dial switches on the 1791DS module.

There is much confusion regarding the Safety Network Number. When the Safety Network Number (SNN) is used, all the devices on any safety network should have the same SNN. If there are two DNBs, and thus twoDeviceNet safety networks, each network should have a unique SNN. This provides a level of safety so that if there were matching node numbers on each DeviceNet network, the SNN is used in combination with the DeviceNet node number to create a unique identifier:

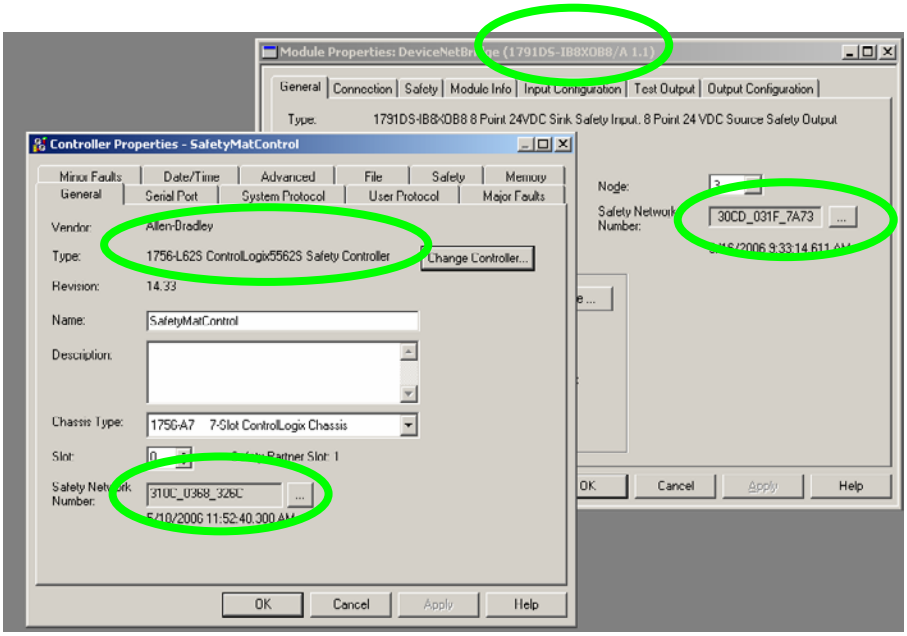
- SNN#1 / node 25
- SNN#2 / node 25

There are two reasons for using a common SNN among all nodes on the subnet.

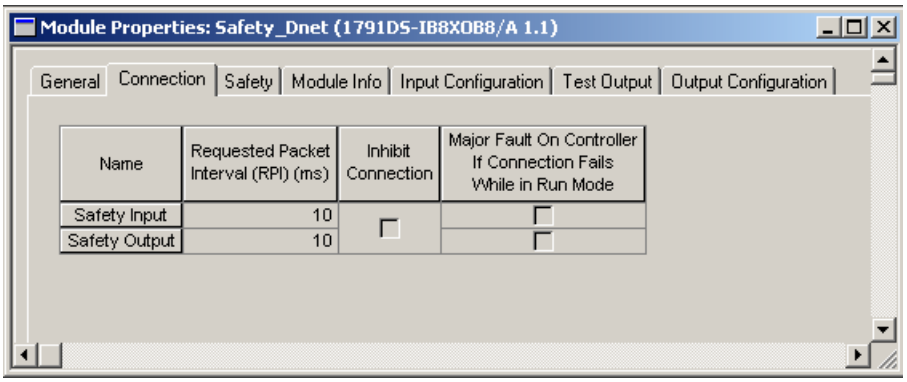
- First, is documentation. It is much easier to recall the SNNs of each node in case of replacement if they are all the same.
- Second, is Auto Device Replacement (ADR). If you replace a DeviceNet node using ADR, it will assume the SNN of the lowest node # on the network. If they are all the same, it will assume the correct SNN.

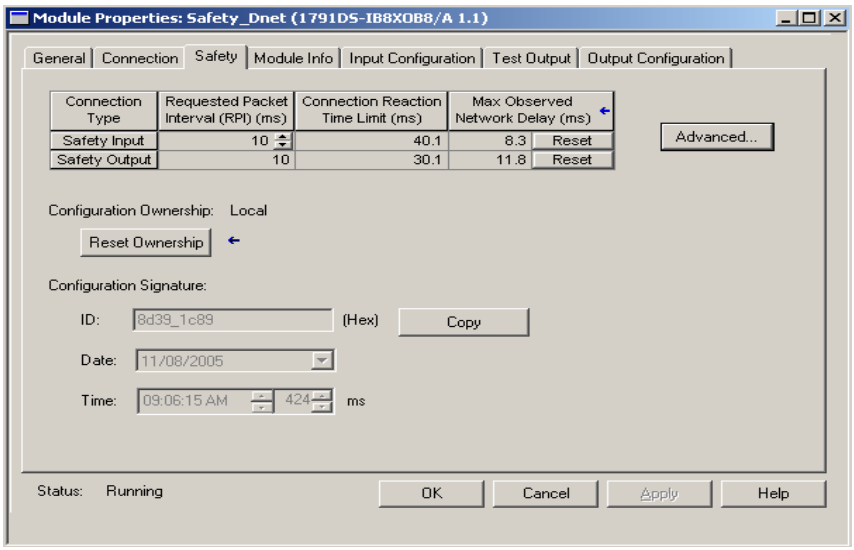
The ControlBus backplane that the GuardLogix controller sits on should have a unique SNN as well. The ControlBus SNN in combination with its slot number creates its unique identifier.

The following screen capture shows that the SNN of the GuardLogix controller and the 1791DS module do not match in the ACD file.



The default data was used in the Connection and Safety tabs shown below. They should be changed based on the throughput requirements of your system.



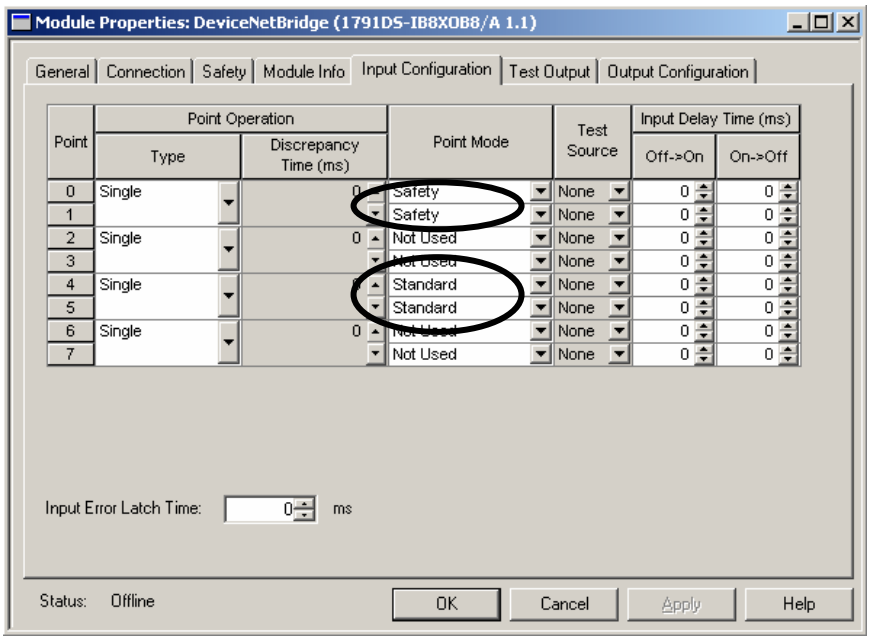


The Input Configuration tab is shown below. There are three choices under Point Mode.

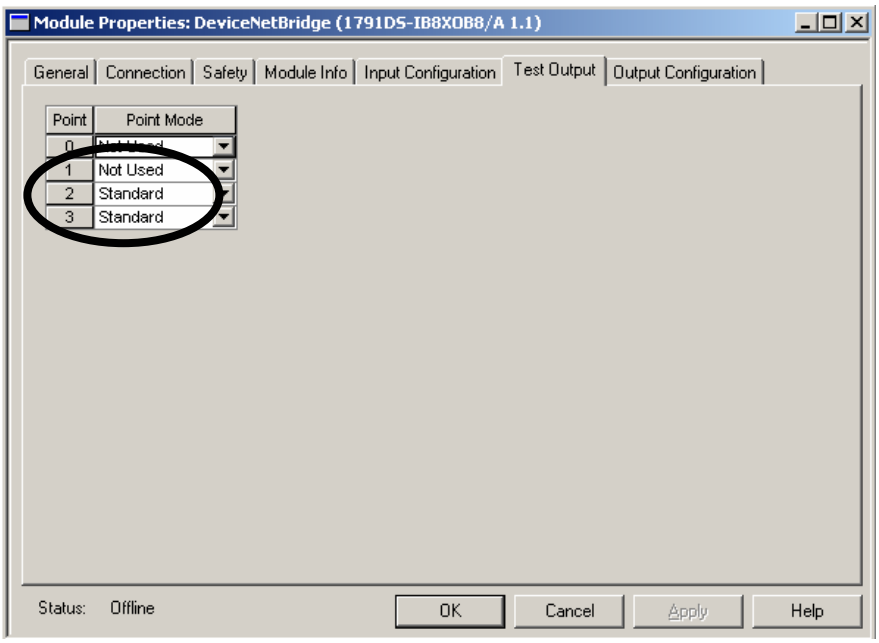
- Standard [input circuits not tested internally]
- Safety [input circuits tested internally]
- Safety Pulse Test [input circuits tested internally and wired to a Test Source for pulse-testing]

Inputs 4 and 5 were used for the Fault reset and Circuit reset push buttons. They are set to Standard because reset buttons are not safety inputs.

Inputs 0 and 1 were used for the safety mat inputs. Since these are safety inputs, they are configured as Safety inputs. They were not configured as Safety Pulse Test because we are not using the on-board pulse-testing feature for the reasons described at the beginning of this document.



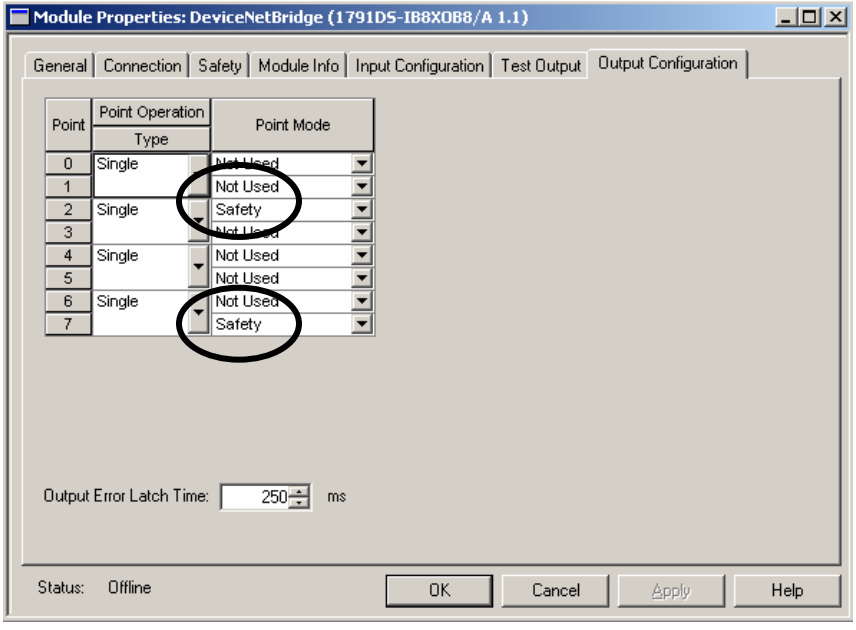
The Test Output configuration is shown below. Test Outputs 2 and 3 are being used as the source for the safety mat channels and are set to Standard. Even though they are not Safe outputs when used in this configuration, the redundancy (two channels) and diagnostics (alternating the outputs makes it possible to detect all wiring faults using ladder logic) allow the channels to achieve at least a Category 3 rating per EN 954-1.



The Output Configuration tab is shown below. The options under Point Mode are:

- Safety.
- Safety Pulse Test.
- not used.

Outputs 2 and 7 are being used as indicators in the ladder code and thus are configured as safety outputs. These indicators could be driven by standard output modules if safety outputs are in short supply.



Reaction to Faults

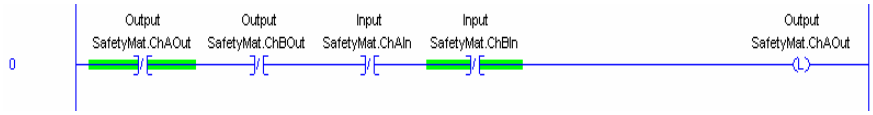
Channel-to-Channel Short / Actual Short or Stepping on Mat						
Channel	Start	Fault	Immediate Reaction	Immediate Detection	Reaction After Toggle	Detection After Toggle
A	HI	ch-ch	HI	Yes		
B	LO	ch-ch	HI	Yes		
Short to 24V dc						
Channel	Start	Fault	Immediate Reaction	Immediate Detection	Reaction After Toggle	Detection After Toggle
A	HI		HI			
B	LO	short	HI	Yes		
A	HI	short	HI	No	HI	Yes
B	LO		LO		HI	
Short to 0V dc						
Channel	Start	Fault	Immediate Reaction	Immediate Detection	Reaction After Toggle	Detection After Toggle
A	HI	short	LO	Yes		
B	LO		LO			
A	HI		HI		LO	
B	LO	Short	LO	No	LO	Yes
Wire OFF						
Channel	Start	Fault	Immediate Reaction	Immediate Detection	Reaction After Toggle	Detection After Toggle
A	HI	off	LO	Yes		
B	LO		LO			
A	HI		HI		LO	
B	LO	off	LO	No	LO	Yes

Other Fault Results

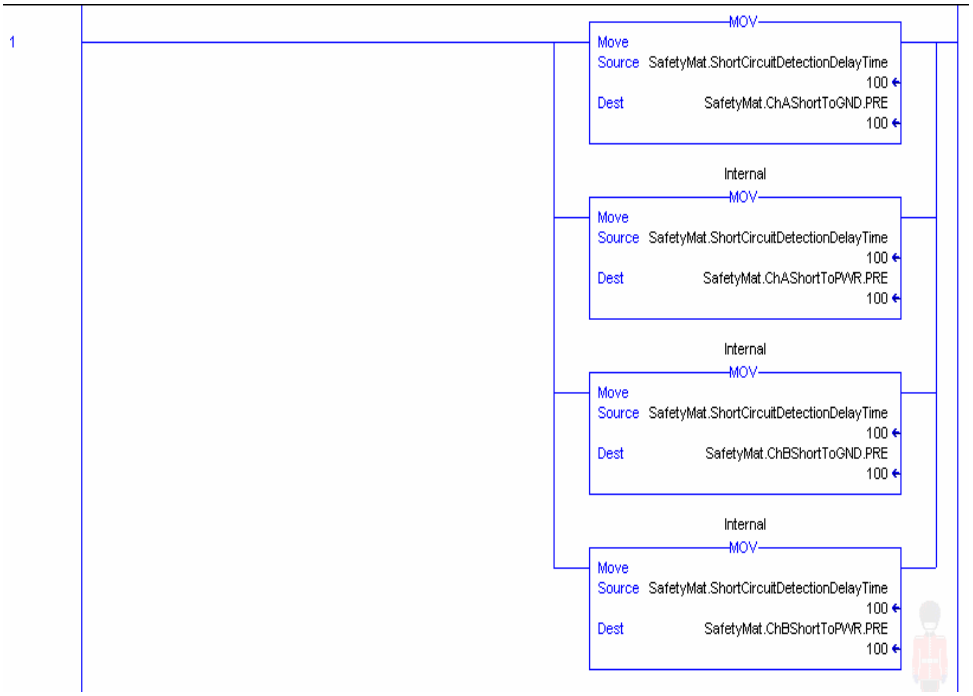
If	Then
Mat is stepped on with a Wire OFF fault and in between toggles…	Output turns off immediately based on where wire came off.
Mat is off on input side of mat…	Outputs short together and generate a fault.
Wire is off on ouput side of mat…	Inputs both go HI and output turns off.

Programming

The safety mat channels are sourced by test outputs and monitored by safety inputs. If all of these are LO, then the output toggling has not started, and is jumpstarted by setting the output for channel A HI.



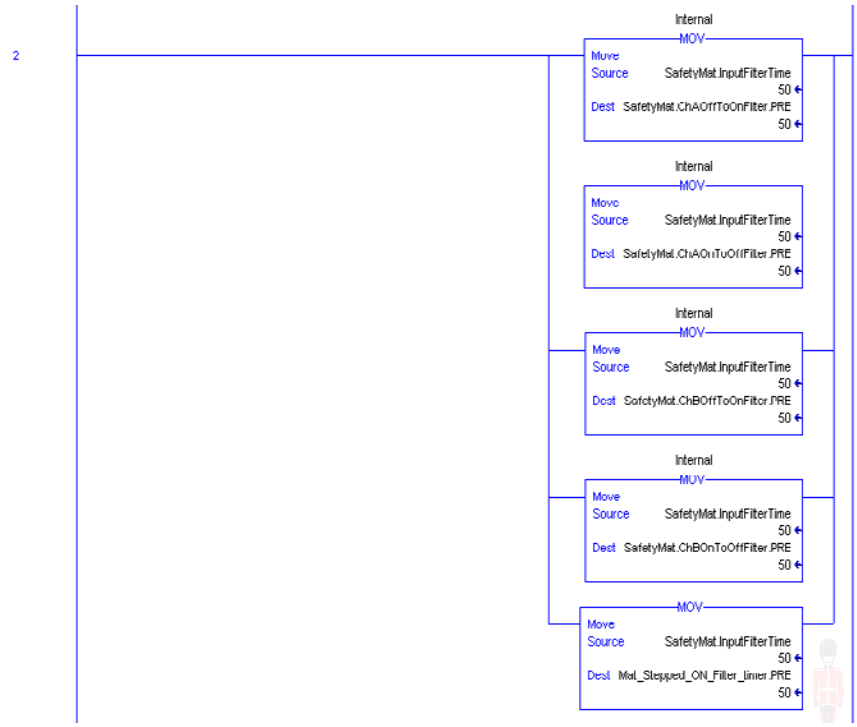
This rung sets the presets for the Short Circuit timers. The Short Circuit timers provide time for the inputs to catch up to the output that is sourcing it. This determines the amount of time to wait for the input to follow the output HI or LO. They begin timing every time the test outputs are toggled. If the inputs track to the same state as the Test Outputs before the timers time out, then no faults are indicated. The preset is entered in the Operator1Mat UDT.



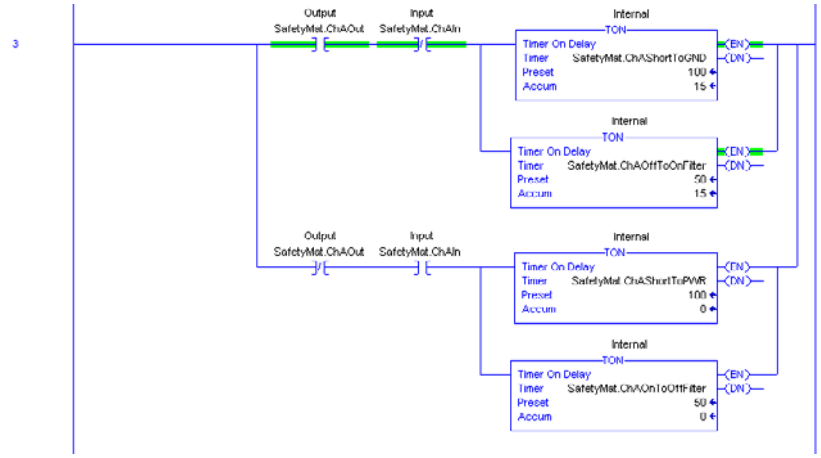
This rung sets the presets for the Filter Timers which operate the same as the Short Circuit Timers. The Filter Timers provide time for the inputs to catch up to the output sourcing it. The filter determines the amount of time for the input to follow the output HI or LO. These filters turn OFF the output if they time out. If the input does not follow the output before the filter timer times out, the safety Mat output must be turned off.

There are four timers, one for each channel shorted to 24V dc and GND. There is also a filter preset for the mat and someone must be on the mat until the filter timer times out to turn off the Mat output. The preset is entered in the Operator1Mat UDT. The Short Circuit timers have nothing to do with turning OFF the output, but are used for fault diagnostics. If the Short Circuit timer is too low (less than 75 ms) it is possible to get incorrect diagnostic indicators. It is, therefore, recommended the Short Circuit timers have a preset no less than 75 ms. If a quicker response time is needed for safety shutdown when the mat is stepped on, then the Filter presets can be set lower.

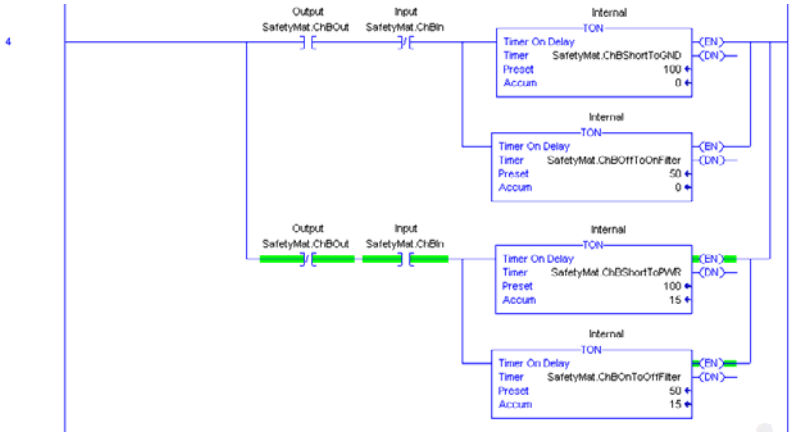
Operator1Mat.InputFilterTime	50		Decimal	DINT



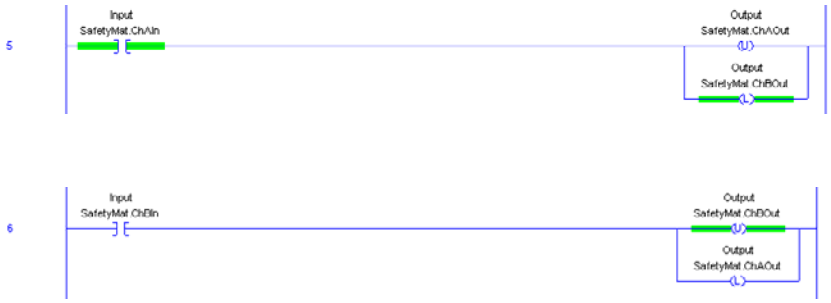
These are the Short Circuit and Filter timers for channel A. They begin running if the Output is HI and the input LO, or vice versa.



These are the Short Circuit and Filter timers for channel B.



The next two rungs keep the outputs toggling. If A output goes HI, then A input should follow. When it does, set A output LO and set B output HI. When B output goes HI, then B input should follow. When it does, set B output LO and set A output HI, and so on.

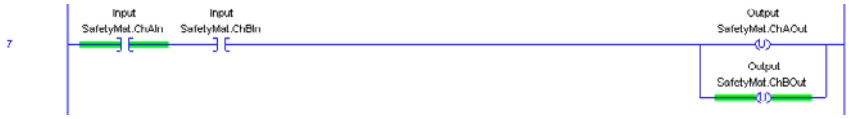


This rung keeps everything working properly when a fault occurs.

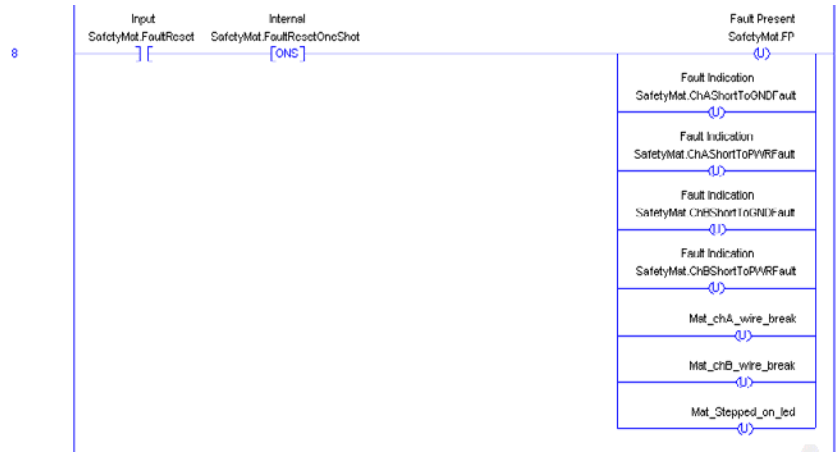
It allows detection of a channel short to 24V dc and it also allows the non-faulted channel to keep toggling, while the faulted channel times out.

This rung also allows detection of a channel-to-channel short. Without it, only channel B will incorrectly be detected as faulted simply due to the order of the rungs. With this rung, both channels toggle together, which can be easily monitored.

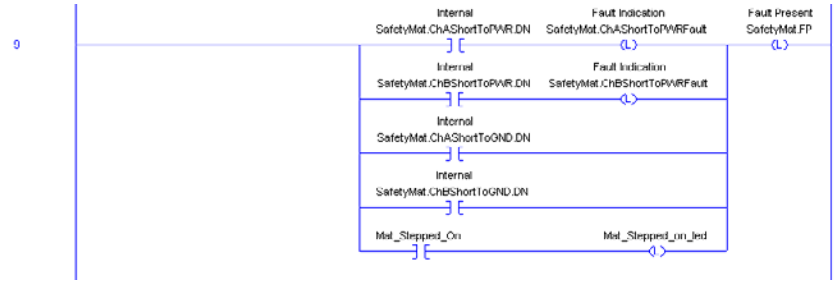
This rung does nothing if a single channel shorts to GND. When that occurs, the toggling simply stops, and the correct channel fault is detected.



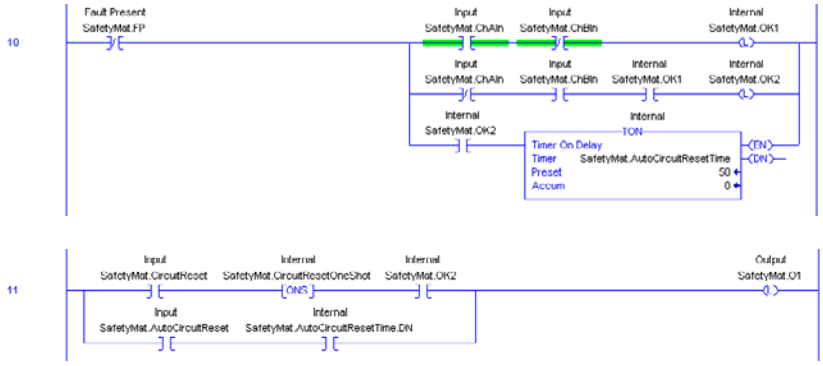
Clear all fault indicators on the rising edge of the fault reset. If the fault still exists, the next run sets the fault again. Once again, this program cannot distinguish between stepping onto the mat and a channel-to-channel short. So the Mat Stepped on LED could actually be the indication for a channel-to-channel short.



Latch the Fault indicators and Fault Present when the Fault timers expire. The Short to GND faults have been removed from this rung and used later, because they are broken down to a more granular level.

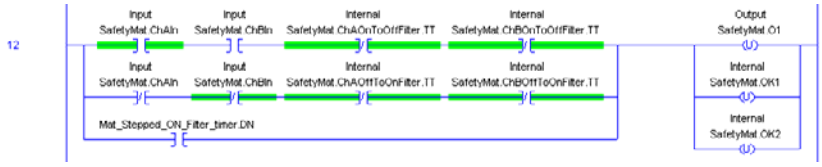


Rungs 10 and 11 allow the restart of the Mat output if there are not faults. Restart requires that the inputs toggle through both safe states (1/0) and (0/1). If using Auto Reset, wait 50 ms after toggling through the safe states before restarting the output. If using Manual Reset, the Circuit Reset must be set HI after toggling through the safe states.

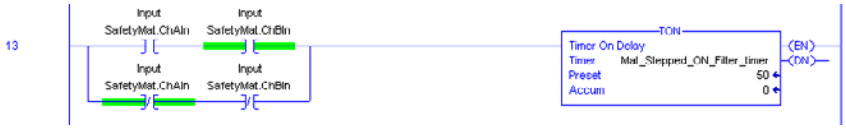


Turn OFF the Mat output if both inputs are in the same state, and the filter timers have expired. This occurs when the outputs are toggled, but only one of the inputs follows their respective outputs to the correct state. The cause is likely that the mat was stepped on, but it could also be a wiring short to 24V dc or GND. Unless the filter timers were set very low, it is very unlikely that network throughput caused the stop. For example, one of the channels was sent through over DeviceNet network, but the other channel was not.

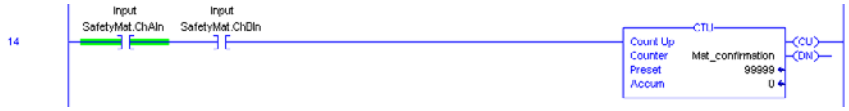
The Mat Stepped ON Filter is required to turn OFF output when the mat is stepped on, because rung 7 causes the outputs to toggle in the same state, and thus the filter timers do not time out, because the inputs are tracking the outputs.



If the mat is stepped on, the outputs (therefore inputs as well) are always in the same state, toggling between HI and LO (once again, due to rung 7). The mat filter timer times out during this condition and turns off the output in the rung above.



When a channel is shorted to GND, both inputs go LO and stay LO. This condition lets the mat filter timer to run, incorrectly. This counter can distinguish between the short to GND and stepping on the mat because it will not count if a short to GND fault occurs.



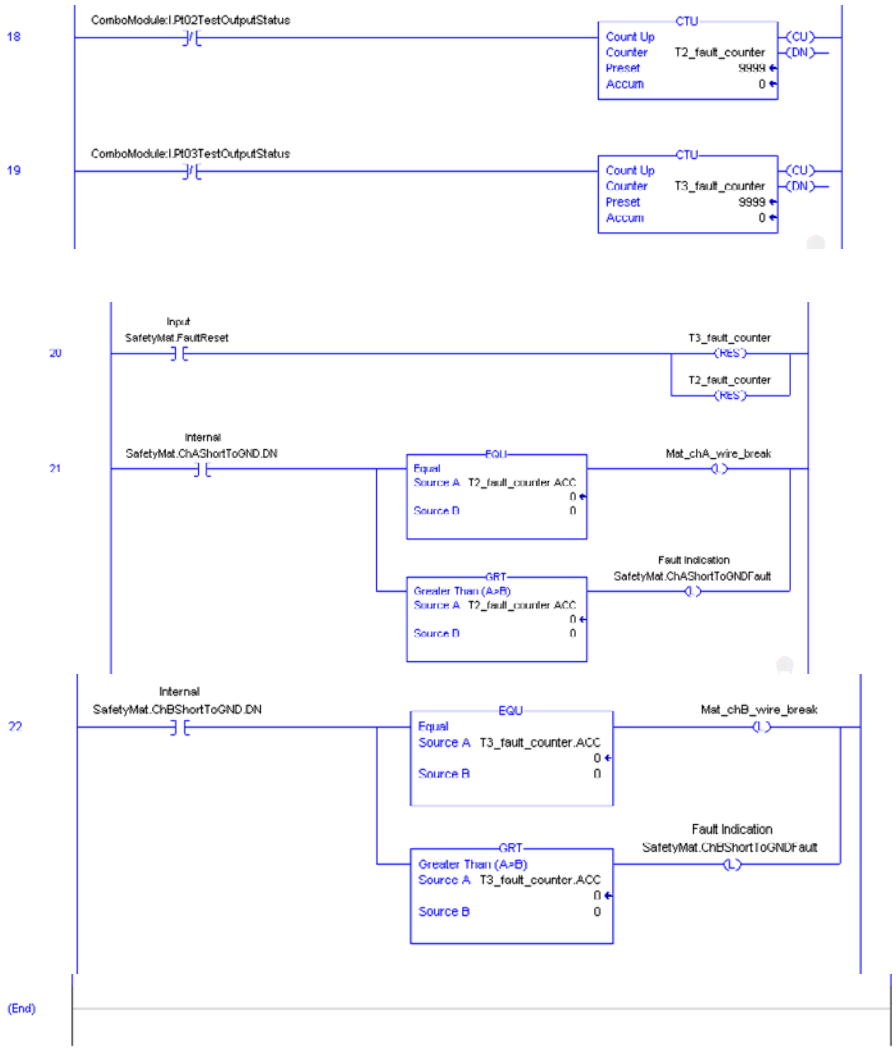
When the mat is stepped on for less than the Mat filter timer, the counter still increments. If this count is not cleared out, the next short to GND could incorrectly be detected as stepping on the mat. The mat filter timer enable bit clears the count when one steps off the mat to ensure that it is cleared out as quickly as possible.

If the Mat Stepped On timer times out, and the Mat confirmation counter is greater than 1, then the mat has been stepped on. A value of 2 or more is used because a short to 24V dc will cause the mat confirmation counter to increment to 1. When the mat is stepped on, the counter increments continuously.

Since there are separate Filter and Short Circuit timers, it is possible that the filter timer drops out the output, yet no fault condition is energized. In these cases, an undetectable fault is declared.

The last five rungs were added to differentiate between a short to GND and a wire OFF condition. Both cause the channel input to go LO, even when the channel output is HI.

Test Output status is required for this differentiation. If a wire break occurs, then the Test Output status remains HI. If a short to GND occurs, the Test Output status toggles at the Input Error Latch time rate. A 5-byte connection is needed to obtain the Test Output status.



Setting the 1791-DS Input Error Latch Time

We recommend that the Input Error Latch Time be set to zero.

Since the Faults are captured in software due to the output toggling, there really is no reason to have to latch the fault. If you do set the Input Error Latch time, the following occurs:

- First, it will have no effect on turning OFF the output in the event of a fault or stepping onto the mat. The Latch time has no effect on the filter timer, so the output will still go LO when the filter timer times out.
- In the event of a fault (stepping onto mat or short circuit), the fault cannot be reset during the Latch time.
- In the event of a channel-to-channel short, stepping on mat, or short to 24V dc, it is likely that both the Short to Power and Short to GND indicators go HI.
- If the mat is stepped on, the mat stepped On indicator may not energize until the Latch timer times out. And only if you are still on the mat.

Setting the Safety Task Period

Set the Period based on the reaction time you require. The lower the period, the quicker the outputs will toggle, and the quicker the reaction time. None of the operational features of the application example are affected; they just run slower as the period increases. The Safety Task Period becomes the 1791-DS module output-connection requested packet interval (RPI).

Setting the RPI of 1791-DS Module

The Requested Packet Interval (RPI) setting affects the operation of the safety mat application in the same way as the period. Lower RPIs result in quicker reaction times. But because the I/O module RPI is asynchronous to the safety task, if the RPI is set higher than the short circuit timer, then you will likely see erroneous fault indications. When the short circuit timer times out, the fault is set. The output will not necessarily go LO if the RPI is higher than the filter timer, because if the inputs are diverse (which they should normally be), the filter timer is ignored.

Setting the Short Circuit Timer Preset

These timers make sure that the channel inputs follow the channel outputs before the timers time out. If the timers time out, the appropriate fault indicator is energized. We recommend setting this preset to the same value as the Filter Preset but no less than 75 ms. If less than 75 ms, then false indicators occur when the mat is stepped on, due to how the faults are handled on the 1791-DS module.

Setting the Filter Timer Preset

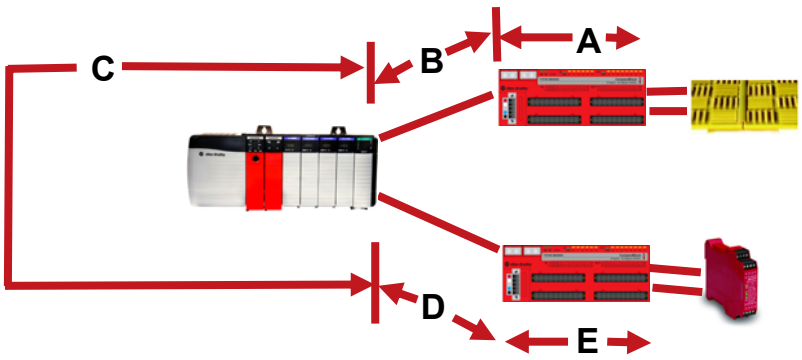
These timers also make sure that the channel inputs follow the channel outputs before the timers time out. Before the output is turned OFF, these timers must time out and the inputs must be in the same state. This can only occur if one of the channels is shorted to 24V dc or GND, or the channels are shorted to each other, or a wire break occurs. If the delay is only due to throughput (RPI or period set HI), and the inputs toggle after the filter timers time out, but always remain in the opposite state, then the filter timers will have timed out without turning off the output. Set this preset based on how quickly the output must be set LO when the mat is stepped on.

Performance Data

Worst Case Reaction Time Based on Period / Task / RPI / Filter Preset

Typically, one channel is HI and one LO. When the mat is stepped on, the channels short together, and both inputs are HI since both have a path to the HI channel. One channel now is HI at the input terminal and the output logically LO. This starts the filter timer, and when it times out, since both inputs are HI, the output is turned OFF.

Worst case, the time it takes to occur is the sum of the A to E path as described below.



A – Input Module delay / 16 ms + on/off delay filters

B – Input Connection Reaction Time Limit (CTRL)

The Connection Reaction Time Limit is configured in RSLogix 5000 1791DS Module Properties. The Input Connection defaults to 4 x RPI.

C – GuardLogix Delay

The maximum delay for the filter timer to time out is:

Period + (Filter Timer / Period)[round UP] x Period + Task Watchdog

Example:

Filter Timer = 50ms

Period = 15ms

Task Watchdog = 10ms

15 + {[(50/15) = 3.33 = 4] x 15} + 10 = 85ms

The First Period accounts for the input just being missed because of the asynchronous Communications.

During Second Period – start timer

During Third Period – time to 15

During Fourth Period – time to 30

During Fifth Period – time to 45

During Last Task Watchdog – time to 50 and set output LO

D – Output Connection Reaction Time Limit

The Connection Reaction Time Limit is configured in RSLogix5000 1791DS Module Properties. The Output Connection defaults to 3 x RPI.

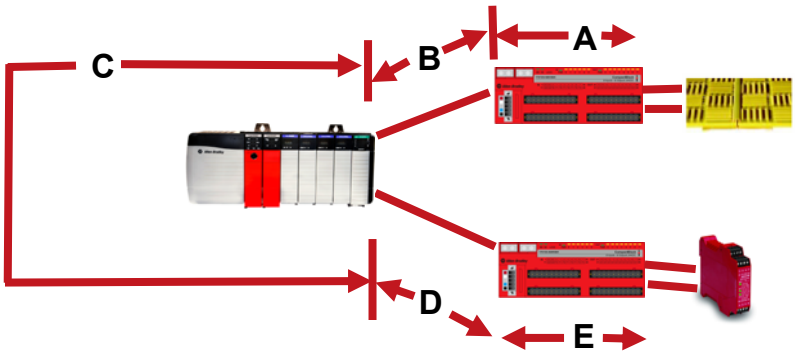
E – Output Module Delay / 6ms (+ 20ms if using OW4 relay outputs)

Worst Case Reaction Time = A + B + C + D + E

Typical Reaction Time Based on Period / Task / RPI / Filter Preset

Typically, one channel is HI and one LO. When the mat is stepped on, the channels short together, and both inputs are HI since both have a path to the HI channel. One channel now is HI at the input terminal and the output logically LO. This starts the filter timer, and when it times out, since both inputs are HI, the output is turned OFF.

Typically, the time it takes to occur is the sum of the A to E path as described below.



A – Input Module delay / (max / 2) = 8ms

B – Input Connection Reaction Time / Input RPI

C – GuardLogix Delay

The maximum delay for the filter timer to time out is:

[Period / 2} + [(Filter Timer / Period)[round UP] x Period] + Task Scan Time

Example:

Filter Timer = 50ms

Period = 15ms

Task Watchdog = 10ms

Task Scan Time = 5ms (assumption)

7.5 + {[(50/15) = 3.33 = 4] x 15} + 5 = 72.5ms

The First Period accounts for the input just being missed because of the asynchronous Communications.

During Second Period – start timer

During Third Period – time to 15

During Fourth Period – time to 30

During Fifth Period – time to 45

During Last Task Watchdog – time to 50 and set output LO

D – Output Connection Reaction Time / Output RPI = Task Period

E – Output Module Dalay / (max / 2) = 3ms

Typical Reaction Time = A + B + C + D + E

Additional Resources

For more information about the products used in this example, refer to these resources.

Resource	Description
CompactBlock Safety I/O Modules on DeviceNet Series 1791DS Installation Instructions, publication 1791DS-IN001	Provides instructions for installing your DeviceNet Safety I/O Module.
Guard I/O DeviceNet Safety Modules User Manual, publication 1791DS-UM001	Provides information for using the Guard I/O DeviceNet Safety Module.
GuardLogix Controller Installation Instructions, publication 1756-IN045	Provides instructions for installing your GuardLogix Controller.
GuardLogix Controller Systems Safety Reference Manual, publication 1756-RM093	Provides safety guidelines for using your GuardLogix Controller.
GuardLogix Controllers User Manual, publication 1756-UM020	Provides information for using your GuardLogix Controller.
Safety Mats Overview, publication 440F-CA500	Provides general information about MatGuard mats, S115.
MatGuard Mats, publication 440F-CA501	Provides MatGuard Mat specifications.
Product Certifications website, http://ab.com	Provides declarations of conformity, certificates and other certification details.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.

You can view or download publications at http://literature.rockwellautomation.com. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

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